Claims: What is claimed is:

1. A friction stir welding tool that is capable of functionally friction stir welding metal matrix composites (MMCs), ferrous alloys, non-ferrous alloys, and superalloys, said friction stir welding tool comprising:

a friction stir welding tool having a shank, a shoulder and a pin, wherein the shoulder is mechanically locked to the shank to thereby prevent rotational movement of the shoulder relative to the shank; and

a superabrasive material disposed on at least a portion of the shoulder and the pin, wherein the superabrasive material has a first phase and a secondary phase, wherein the superabrasive material is manufactured under an ultra high temperature and an ultra high pressure process;

and wherein the friction stir welding tool is capable of functionally friction stir welding MMCs, ferrous alloys, non-ferrous alloys, and superalloys.

2. The tool as defined in claim 1 wherein the tool further comprises the superabrasive being selected from the group of materials comprised of compounds including

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elements extending from IIIA, IVA, VA, VIA, IIIB, IVB, and VB on the periodic table of the elements.

3. The tool as defined in claim 2 wherein the tool further comprises selecting polycrystalline cubic boron nitride (PCBN) or polycrystalline diamond (PCD) as the superabrasive material.

4. The tool as defined in claim 2 wherein the tool further comprises utilizing a whisker reinforced superabrasive material to thereby inhibit spalling of the superabrasive material.

5. The tool as defined in claim 2 wherein the tool further comprises selecting the superabrasive material in order to obtain a desired balance between chemical wear and mechanical wear of the friction stir welding tool.

6. The tool as defined in claim 2 wherein the tool further comprises the shank, wherein a material for the shank is selected from the group of materials comprised of

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cemented tungsten carbide, steels, and superabrasive materials.

7. The tool as defined in claim 2 wherein the tool further comprises an internal cooling system for cooling the friction stir welding tool.

8. The tool as defined in claim 1 wherein the tool further comprises at least a second material disposed over the superabrasive coating to thereby contribute properties of the second material to the superabrasive coating.

9. The tool as defined in claim 2 wherein the tool further comprises a first thermal flow barrier disposed between the shoulder and the shank to thereby regulate movement of heat from the shoulder to the shank.

10. The tool as defined in claim 9 wherein the tool further comprises a locking collar, the locking collar performing the function of mechanically locking the shoulder to the shank to thereby prevent rotational movement of the shoulder relative to the shank.

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11. The tool as defined in claim 10 wherein the tool further comprises a second thermal flow barrier disposed between the locking collar and the portion of the shoulder and the shank around which it is disposed, to thereby regulate movement of heat from the shoulder and the shank to the locking collar.

12. The tool as defined in claim 11 wherein the first thermal flow barrier and the second thermal flow barrier further comprises titanium alloys.

13. The tool as defined in claim 12 wherein the shank further comprises a material that is selected having a thermal conductivity that is less than the shoulder, the pin and the locking collar.

14. The tool as defined in claim 13 wherein the shank is selected from the group of materials comprised of cemented tungsten carbide, tungsten alloys, steels, molybdenum alloys, and superalloys.

15. The tool as defined in claim 14 wherein the tool

further comprises providing at least one surface feature disposed along a lengthwise axis of the tool, wherein the surface feature enables the locking collar to more securely restrain the shoulder and the shank in a same relative position.

16. The tool as defined in claim 15 wherein the tool further comprises selecting the at least one surface feature from the group of surface features comprising a flat, a spline, a keyway and key, a locking pin, a dovetail, and a dentation.

17. The tool as defined in claim 16 wherein the tool further comprises a mechanical lock between the shank working end and the shoulder attaching end, the mechanical lock being selected from the group of mechanical locks comprised of dovetails, splines, and dentations.

18. The tool as defined in claim 17 wherein the shoulder further comprises a shoulder radii disposed about a working edge thereof, the shoulder radii functioning as a crack inhibitor in the superabrasive material.

19. The tool as defined in claim 18 wherein the means for mechanically locking the shoulder to the shank is selected from the group of mechanical locking means comprised of splines, locking pins, dovetails, and dentations.

20. The tool as defined in claim 19 wherein the tool further comprises the locking collar, wherein the material selected for the locking collar is a superalloy.

21. The tool as defined in claim 20 wherein the tool further comprises the locking collar, wherein a material selected for the locking collar is selected from the group of materials comprised of nickel-cobalt and cobalt-chromium.

22. A friction stir welding tool that is capable of friction stir welding metal matrix composites (MMCs), ferrous alloys, non-ferrous alloys, and superalloys, said friction stir welding tool being a monolithic device comprising:

a shank having a shaft attaching end and a shaft working end;

a shoulder formed on the shaft working end, the shoulder having a shoulder working edge, wherein the shoulder working edge is formed as a radii;

a pin formed in the shoulder, wherein the pin is concentric with and parallel to a lengthwise axis of the shoulder from which it extends outwardly, and wherein a first pin radii is formed at a junction between the shoulder and the pin, and a second pin radii is formed at a pin working edge.

a superabrasive material disposed on at least a portion of the shoulder and the pin, and wherein the friction stir welding tool is capable of functionally friction stir welding MMCs, ferrous alloys, non-ferrous alloys, and superalloys.

23. A method for friction stir welding metal matrix composites (MMCs), ferrous alloys, non-ferrous alloys, and superalloys, said method comprising the steps of:

(1) providing a friction stir welding tool having a shank, a shoulder and a pin;

(2) mechanically locking the shoulder to the shank to thereby prevent rotational movement of the shoulder relative to the shank; and

(3) disposing a superabrasive material on at least a portion of the shoulder and the pin, wherein the superabrasive material has a first phase and a secondary phase, wherein the superabrasive material is manufactured under an ultra high temperature and an ultra high pressure process, and wherein the friction stir welding tool is capable of functionally friction stir welding MMCs, ferrous alloys, non-ferrous alloys, and superalloys.

24. The method as defined in claim 23 wherein the method further comprises the step of selecting the superabrasive material from the group of materials comprised of compounds including elements extending from IIIA, IVA, VA, VIA, IIIB, IVB, and VB on the periodic table of the elements.

25. The method as defined in claim 24 wherein the method further comprises the step of selecting polycrystalline cubic boron nitride (PCBN) or

polycrystalline diamond (PCD) as the superabrasive material.

26. The method as defined in claim 25 wherein the method further comprises the step of inhibiting spalling of the superabrasive material by utilizing a whisker reinforced superabrasive material.

27. The method as defined in claim 26 wherein the method further comprises the step of achieving a balance between chemical wear and mechanical wear of the friction stir welding tool by selecting the superabrasive material having a first percentage of first phase material, and having a second percentage of second phase material.

28. The method as defined in claim 27 wherein the method further comprises the step of selecting a hardened material for the shank, wherein the shank material is selected from the group of materials comprised of cemented tungsten carbide, steels, and superabrasive materials.

29. The method as defined in claim 24 wherein the method

further comprises the step of disposing at least a second material over the superabrasive coating to thereby contribute properties of the second material to the superabrasive coating.

30. The method as defined in claim 29 wherein the method further comprises the step of applying the at least a second material over the superabrasive coating selecting an application method from the group of application methods comprised of CVD, ion-beam implantation, and PVD.

31. The method as defined in claim 30 wherein the method further comprises the step of regulating movement of heat between the shoulder and the shank by disposing a first thermal flow barrier between the shoulder and the shank.

32. The method as defined in claim 31 wherein the method further comprises the step of preventing rotational movement of the shoulder relative to the shank by providing a locking collar to mechanically lock the shoulder to the shank.

33. The method as defined in claim 32 wherein the method further comprises the step of regulating movement of heat from the shoulder and the shank to the locking collar by providing a second thermal flow barrier between the locking collar and the portion of the shoulder and the shank around which it is disposed.

34. The method as defined in claim 33 wherein the method further comprises the step of providing titanium alloys as the first thermal flow barrier and the second thermal flow barrier.

35. The method as defined in claim 34 wherein the method further comprises the step of regulating movement of heat within the friction stir tool by selecting a material for the shank that has a lower thermal conductivity than is less than the shoulder, the pin and the locking collar.

36. The method as defined in claim 35 wherein the method further comprises the step of selecting the material for the shank from the group of materials comprised of

cemented tungsten carbide, tungsten alloys, steels, molybdenum alloys, and superalloys.

37. The method as defined in claim 36 wherein the method further comprises the step of inhibiting crack propagation in the superabrasive material on the shoulder by providing a shoulder radii disposed about a working edge thereof.

38. The method as defined in claim 37 wherein the method further comprises the step of selecting a superalloy for the locking collar to thereby prevent rotational movement of the shoulder relative to the shank.

39. The method as defined in claim 38 wherein the method further comprises the step of selecting a superalloy for the locking collar from the group of superalloys comprised of nickel-cobalt and cobalt-chromium.

40. The method as defined in claim 24 wherein the method further comprises the step of reducing stress risers on the shoulder and on the pin, to thereby inhibit crack propagation of the superabrasive material.

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41. The method as defined in claim 40 wherein the method further comprises the steps of:

(1) forming the shank as a generally cylindrical object; and

(2) providing the shoulder as a disk-like object, wherein the pin is an integral component of the shoulder, wherein the pin is generally cylindrical, and wherein the pin is concentric with and parallel to a lengthwise axis of the shoulder from which it extends.

42. The method as defined in claim 41 wherein the method further comprises the step of providing a locking collar, the locking collar mechanically locking the shoulder to the shank to thereby prevent rotational movement of the shoulder relative to the shank.

43. The method as defined in claim 24 wherein the method further comprises the step of making an improved friction stir weld by providing a friction stir welding tool that inhibits materials from adhering to the friction stir welding tool during the welding process by utilizing a

superabrasive material having a low coefficient of friction.

44. The method as defined in claim 24 wherein the method further comprises the step of regulating a pin diameter to pin length ratio to thereby control characteristics of a weld.

45. The method as defined in claim 24 wherein the method further comprises the steps of:

(1) providing a shank having a shaft working end and a shaft attaching end, wherein a shank bore hole is disposed from the shaft working end to the shaft attaching end, and wherein the shank bore hole is concentric with a lengthwise axis;

(2) providing a shoulder having the form of a disk, wherein a shoulder hole is aligned with the shank bore hole, and wherein the shoulder is coupled to the shank, wherein the shoulder is mechanically locked to the shank, thereby preventing rotation of the shoulder relative to the shank; and

(3) providing a pin disposed through the shoulder hole and at least partially into the shank bore hole, wherein a portion of the pin is disposed outside the shoulder hole, and wherein the pin is mechanically locked to the shank, thereby preventing movement rotation of the pin relative to the shank.

46. The method as defined in claim 24 wherein the method further comprises the step of increasing a rate of flow of material around the pin during a friction stir welding process to thereby improve characteristics of a weld.

47. The method as defined in claim 46 wherein the method further comprises the step of creating transitional flow or turbulent flow of material around the pin.

48. The method as defined in claim 24 wherein the method further comprises the step of reducing wear on the friction stir welding tool by utilizing a superabrasive material having a low coefficient of friction.

49.. The method as defined in claim 24 wherein the method

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of friction stir welding MMCs, ferrous alloys, non-ferrous alloys, and superalloys further comprises the step of utilizing thermal management to thereby regulate thermal wear of the friction stir welding tool.

50. The method as defined in claim 49 wherein the method further comprises the step of utilizing superabrasives to thereby reduce mechanical wear and chemical wear of the friction stir welding tool.

51. The method as defined in claim 51 wherein the method further comprises the step of providing thermal flow barriers to regulate movement of heat within the friction stir welding tool.

52. The method as defined in claim 51 wherein the method further comprises the step of controlling geometry of the friction stir welding tool to enable use of superabrasives.

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